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Elliptical Orbits Formulas

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List of 22 Elliptical Orbits Formulas

Elliptical Orbits ↗

1) Angular Momentum in Elliptic Orbit Given Apogee Radius and Apogee Velocity ↗

fx $h = r_{\text{apogee}} \cdot v_{\text{apogee}}$

[Open Calculator ↗](#)

ex $66419.5 \text{ km}^2/\text{s} = 27110 \text{ km} \cdot 2.45 \text{ km/s}$

2) Angular Momentum in Elliptic Orbit Given Perigee Radius and Perigee Velocity ↗

fx $h = r_{\text{perigee}} \cdot v_{\text{perigee}}$

[Open Calculator ↗](#)

ex $65746.6 \text{ km}^2/\text{s} = 6778 \text{ km} \cdot 9.7 \text{ km/s}$

3) Apogee Radius of Elliptic Orbit Given Angular Momentum and Eccentricity ↗

fx $r_{\text{apogee}} = \frac{h^2}{[\text{GM.Earth}] \cdot (1 - e_e)}$

[Open Calculator ↗](#)

ex $27114.01 \text{ km} = \frac{(65750 \text{ km}^2/\text{s})^2}{[\text{GM.Earth}] \cdot (1 - 0.6)}$



4) Apogee Velocity in Elliptic Orbit Given Angular Momentum and Apogee Radius ↗

fx $v_{\text{apogee}} = \frac{h}{r_{\text{apogee}}}$

[Open Calculator ↗](#)

ex $2.425304 \text{ km/s} = \frac{65750 \text{ km}^2/\text{s}}{27110 \text{ km}}$

5) Azimuth-Averaged Radius Given Apogee and Perigee Radii ↗

fx $r_{\theta} = \sqrt{r_{\text{apogee}} \cdot r_{\text{perigee}}}$

[Open Calculator ↗](#)

ex $13555.5 \text{ km} = \sqrt{27110 \text{ km} \cdot 6778 \text{ km}}$

6) Eccentricity of Elliptical Orbit given Apogee and Perigee ↗

fx $e_e = \frac{r_{\text{apogee}} - r_{\text{perigee}}}{r_{\text{apogee}} + r_{\text{perigee}}}$

[Open Calculator ↗](#)

ex $0.599976 = \frac{27110 \text{ km} - 6778 \text{ km}}{27110 \text{ km} + 6778 \text{ km}}$



7) Elliptical Orbit Time Period given Angular Momentum and Eccentricity


[Open Calculator](#)

fx $T_{\text{or}} = \frac{2 \cdot \pi}{[\text{GM.Earth}]^2} \cdot \left(\frac{h}{\sqrt{1 - e_e^2}} \right)^3$

ex $21954.4\text{s} = \frac{2 \cdot \pi}{[\text{GM.Earth}]^2} \cdot \left(\frac{65750\text{km}^2/\text{s}}{\sqrt{1 - (0.6)^2}} \right)^3$

8) Radial Velocity in Elliptic Orbit given Radial Position and Angular Momentum


[Open Calculator](#)

fx $v_r = \frac{h}{r}$

ex $4.847033\text{km/s} = \frac{65750\text{km}^2/\text{s}}{13565\text{km}}$

9) Radial Velocity in Elliptic Orbit given True Anomaly, Eccentricity, and Angular Momentum


[Open Calculator](#)

fx $v_r = [\text{GM.Earth}] \cdot e_e \cdot \frac{\sin(\theta)}{h}$

ex $3.439247\text{km/s} = [\text{GM.Earth}] \cdot 0.6 \cdot \frac{\sin(109^\circ)}{65750\text{km}^2/\text{s}}$



10) Semimajor Axis of Elliptic Orbit given Apogee and Perigee Radii ↗

$$fx \quad a_e = \frac{r_{\text{apogee}} + r_{\text{perigee}}}{2}$$

Open Calculator ↗

$$ex \quad 16944\text{km} = \frac{27110\text{km} + 6778\text{km}}{2}$$

11) Specific Energy of Elliptic Orbit given Angular Momentum ↗

$$fx \quad \varepsilon = -\frac{1}{2} \cdot \frac{\mu^2}{h^2} \cdot (1 - e_e^2)$$

Open Calculator ↗

$$ex \quad -11725317.410979\text{J/kg} = -\frac{1}{2} \cdot \frac{(3.98E14\text{m}^3/\text{s}^2)^2}{(65750\text{km}^2/\text{s})^2} \cdot (1 - (0.6)^2)$$

12) Specific Energy of Elliptic Orbit given Semi Major Axis ↗

$$fx \quad \varepsilon = -\frac{\mu}{2 \cdot a_e}$$

Open Calculator ↗

$$ex \quad -11747343.565525\text{J/kg} = -\frac{3.98E14\text{m}^3/\text{s}^2}{2 \cdot 16940\text{km}}$$

13) Time Period for One Complete Revolution given Angular Momentum

$$fx \quad T_{\text{or}} = \frac{2 \cdot \pi \cdot a_e \cdot b}{h}$$

Open Calculator ↗

$$ex \quad 15346.38\text{s} = \frac{2 \cdot \pi \cdot 16940\text{km} \cdot 9480\text{km}}{65750\text{km}^2/\text{s}}$$



14) Time Period of Elliptical Orbit given Angular Momentum 

fx $T_{\text{or}} = \frac{2 \cdot \pi}{\mu^2} \cdot \left(\frac{h}{\sqrt{1 - e_e^2}} \right)^3$

Open Calculator 

ex $22020.7 \text{s} = \frac{2 \cdot \pi}{(3.98E14 \text{m}^3/\text{s}^2)^2} \cdot \left(\frac{65750 \text{km}^2/\text{s}}{\sqrt{1 - (0.6)^2}} \right)^3$

15) Time Period of Elliptical Orbit given Semi-Major Axis 

fx $T_{\text{or}} = 2 \cdot \pi \cdot a_e^2 \cdot \frac{\sqrt{1 - e_e^2}}{h}$

Open Calculator 

ex $21938.2 \text{s} = 2 \cdot \pi \cdot (16940 \text{km})^2 \cdot \frac{\sqrt{1 - (0.6)^2}}{65750 \text{km}^2/\text{s}}$

16) True Anomaly in Elliptic Orbit Given Radial Position, Eccentricity, and Angular Momentum 

fx $\theta = a \cos \left(\frac{\frac{h^2}{[\text{GM.Earth}] \cdot r} - 1}{e_e} \right)$

Open Calculator 

ex $109.519^\circ = a \cos \left(\frac{\frac{(65750 \text{km}^2/\text{s})^2}{[\text{GM.Earth}] \cdot 13565 \text{km}} - 1}{0.6} \right)$



Orbital Position as Function of Time ↗

17) Eccentric Anomaly in Elliptic Orbit given True Anomaly and Eccentricity ↗

fx $E = 2 \cdot a \tan \left(\sqrt{\frac{1 - e_e}{1 + e_e}} \cdot \tan \left(\frac{\theta}{2} \right) \right)$

[Open Calculator ↗](#)

ex $70.05892^\circ = 2 \cdot a \tan \left(\sqrt{\frac{1 - 0.6}{1 + 0.6}} \cdot \tan \left(\frac{109^\circ}{2} \right) \right)$

18) Mean Anomaly in Elliptic Orbit given Eccentric Anomaly and Eccentricity ↗

fx $M = E - e_e \cdot \sin(E)$

[Open Calculator ↗](#)

ex $68.37376^\circ = 102^\circ - 0.6 \cdot \sin(102^\circ)$

19) Mean Anomaly in Elliptic Orbit given Time since Periapsis ↗

fx $M = \frac{2 \cdot \pi \cdot t}{T_{\text{or}}}$

[Open Calculator ↗](#)

ex $240^\circ = \frac{2 \cdot \pi \cdot 14000\text{s}}{21000\text{s}}$



20) Time since Periapsis in Elliptic Orbit given Eccentric Anomaly and Time Period ↗

$$fx \quad t = (E - e_e \cdot \sin(E)) \cdot \frac{T_{or}}{2 \cdot \Pi(6)}$$

[Open Calculator ↗](#)

$$ex \quad 4176.715s = (102^\circ - 0.6 \cdot \sin(102^\circ)) \cdot \frac{21000s}{2 \cdot \Pi(6)}$$

21) Time since Periapsis in Elliptic Orbit given Mean Anomaly ↗

$$fx \quad t = M \cdot \frac{T_{or}}{2 \cdot \pi}$$

[Open Calculator ↗](#)

$$ex \quad 4666.667s = 80^\circ \cdot \frac{21000s}{2 \cdot \pi}$$

22) True Anomaly in Elliptic Orbit given Eccentric Anomaly and Eccentricity ↗

$$fx \quad \theta = 2 \cdot a \tan \left(\sqrt{\frac{1 + e_e}{1 - e_e}} \cdot \tan \left(\frac{E}{2} \right) \right)$$

[Open Calculator ↗](#)

$$ex \quad 135.9147^\circ = 2 \cdot a \tan \left(\sqrt{\frac{1 + 0.6}{1 - 0.6}} \cdot \tan \left(\frac{102^\circ}{2} \right) \right)$$



Variables Used

- a_e Semi Major Axis of Elliptic Orbit (*Kilometer*)
- b Semi Minor Axis of Elliptic Orbit (*Kilometer*)
- E Eccentric Anomaly (*Degree*)
- e_e Eccentricity of Elliptical Orbit
- h Angular Momentum of Orbit (*Square Kilometer per Second*)
- M Mean Anomaly (*Degree*)
- r Radial Position of Satellite (*Kilometer*)
- r_{apogee} Apogee Radius (*Kilometer*)
- r_{perigee} Perigee Radius (*Kilometer*)
- r_θ Azimuth Averaged Radius (*Kilometer*)
- t Time since Periapsis (*Second*)
- T_{or} Time Period of Orbit (*Second*)
- v_{apogee} Velocity of Satellite at Apogee (*Kilometer per Second*)
- v_{perigee} Velocity of Satellite at Perigee (*Kilometer per Second*)
- v_r Radial Velocity of Satellite (*Kilometer per Second*)
- ϵ Specific Energy of Orbit (*Joule per Kilogram*)
- θ True Anomaly (*Degree*)
- μ Standard Gravitational Parameter (*Cubic Meter per Square Second*)



Constants, Functions, Measurements used

- **Constant:** **pi**, 3.14159265358979323846264338327950288
Archimedes' constant
- **Constant:** **[GM.Earth]**, $3.986004418 \times 10^{14} \text{ m}^3 \text{ s}^{-2}$
Earth's Geocentric Gravitational Constant
- **Function:** **acos**, $\text{acos}(\text{Number})$
Inverse trigonometric cosine function
- **Function:** **atan**, $\text{atan}(\text{Number})$
Inverse trigonometric tangent function
- **Function:** **cos**, $\text{cos}(\text{Angle})$
Trigonometric cosine function
- **Function:** **Pi**, $\text{Pi}(\text{Number})$
Prime-counting function - $\text{Pi}(n)$
- **Function:** **sin**, $\text{sin}(\text{Angle})$
Trigonometric sine function
- **Function:** **sqrt**, $\text{sqrt}(\text{Number})$
Square root function
- **Function:** **tan**, $\text{tan}(\text{Angle})$
Trigonometric tangent function
- **Measurement:** **Length** in Kilometer (km)
Length Unit Conversion 
- **Measurement:** **Time** in Second (s)
Time Unit Conversion 
- **Measurement:** **Speed** in Kilometer per Second (km/s)
Speed Unit Conversion 
- **Measurement:** **Angle** in Degree ($^\circ$)
Angle Unit Conversion 



- **Measurement:** **Specific Energy** in Joule per Kilogram (J/kg)
Specific Energy Unit Conversion 
- **Measurement:** **Gravitational Parameter** in Cubic Meter per Square Second (m^3/s^2)
Gravitational Parameter Unit Conversion 
- **Measurement:** **Specific Angular Momentum** in Square Kilometer per Second (km^2/s)
Specific Angular Momentum Unit Conversion 



Check other formula lists

- [Elliptical Orbits Formulas](#) ↗
- [Hyperbolic Orbits Formulas](#) ↗
- [Parabolic Orbits Formulas](#) ↗

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